Space Weather Technical Forecast

Issued on Thursday, 09 November 2023 at 13:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Active fluence (1e8 integrated pfu) expected from later Day 1 (09 Nov). Chance of isolated M-class flares.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Activity has been Low with only C-class flares observed in the last 24 hours, the largest of which came from the AR3483 region, near centre disc, peaking at C4.2 at 08/2013 UTC. There are currently seven regions on the visible disc.

The most complex regions on the disc are AR3479 (Dri/Beta), close to the western limb, and AR3483 (Eai/Beta-Gamma), near centre disc. The viewing angle of AR3479 is limited however, with decreasing confidence in classification. AR3483 has spread longitudinally through 09 Nov and there are signs that delta spot may be developing. The largest region on the disc remains AR3477 (Eko/Beta) in the southwest. The trailing spots have largely faded to pores, although close to the lead spot, growth and decay of intermediate spots remains ongoing. The remaining regions are predominantly small, simple and stable.

No Earth-directed CMEs have been observed in the past 24 hours. However, a dimming event just west of the centre disc commenced around 09/1100 UTC. Analysis of this will be completed once imagery is available.

Solar Wind / Geomagnetic Activity: Solar winds at L1, as observed by DSCOVR and ACE, showed the continued enhancement from a high speed stream associated with CH67/-. Wind speeds have remained strong, fluctuating between 650-750 km/s. However, no data has been received from ACE since around 08/2100 UTC. As such, solar wind speeds are being approximated using DSCOVR data and the previously observed difference of 200-250 km/s between the two spacecraft readings. Density has remained below average. Total interplanetary magnetic field strength (Bt) has been weak and consistently between 3-5nT. The north-south component (Bz) varied weakly between -5 and +5 nT. Phi angle has been predominantly negative (towards the Sun), with just a few brief variations. Geomagnetic activity has been Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background levels over the last 24 hours. GOES16 high energy (greater than 2MeV) electron flux was at moderate levels initially, but rose to a diurnal peak at high levels, peaking at 1.23e3 pfu at 08/1520UTC and returned to high levels at 09/1135 UTC. The associated 24-hour fluence has remained steady and below the Active threshold (1e8 integrated pfu), values remain close to the threshold however. The fluence observation at 09/0000 UTC was 4.76e7 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Generally Low solar activity is expected through the period, but with a chance of isolated M-class flares. This risk is expected to increase slightly by Day 3 (11 Nov) due to a combination of emerging or returning regions, and the continued development of regions already on the disc.

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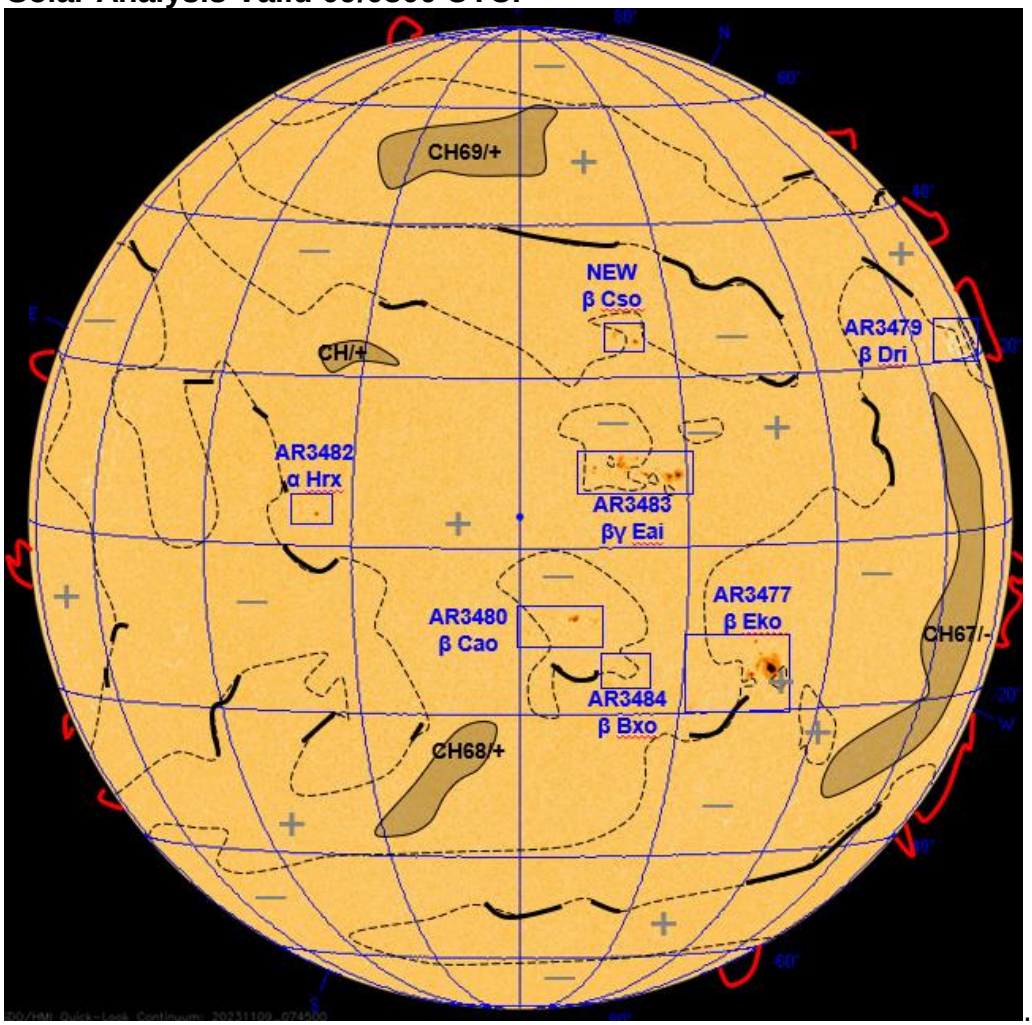
Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are expected in the current forecast period. Strong wind speeds are likely to continue through Day 1 (9 Nov) due to the ongoing HSS from CH67/-, before a gradual decline through Days 2 and 3 (10-11 Nov). Further weak enhancement from smaller coronal holes on the disc is possible by Day 4 (12 Nov) but this is low confidence.

Geomagnetic activity expected to be initially Quiet to Unsettled (Kp 1-3) with a chance of Active intervals on Day 1. In the absence of further enhancement, activity is expected to gradually decline to predominantly Quiet (Kp 0-2) levels.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is most likely to remain at background levels. High energy electron flux (greater than 2MeV) is currently expected to be moderate with diurnal periods at high levels. There is a chance that the electron flux may remain at high levels for protracted periods Days 1-3 (09-12 Nov). The associated 24-hour electron fluence will initially lie below, but close to, the Active threshold but there is an expectation of exceeding the Active (1e8 integrated pfu) threshold later Day 1 (9 Nov). Once exceeded, levels are anticipated to remain above the Active threshold through the period with a very slight chance of reaching 1e9 integrated pfu.

Figure 1. Solar Analysis Valid 09/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are currently forecast. A dimming event just west of centre disc commenced around 09/1100 UTC, disruption to flux lines on AIA/0171 imagery suggests that some ejecta may been released. Analysis of this feature will be completed once imagery is available.

Ongoing enhancement from a HSS from CH67/- sees strong solar wind speeds of around 700 km/s. However, this value is approximated due to an ongoing outage of the data stream from ACE (since 08/2100 UTC). When both feeds were available, DSCOVR had consistently been showing values 200-250 km/s slower than ACE, suggesting current wind speeds of 675-725 km/s.

Winds are expected to continue at strong levels through Day 1 (09 Nov) before beginning to decline from Day 2 (10 Nov). The southern portion of CH67/- slopes eastwards which could see stronger solar winds persist until Day 3, but this is considered low confidence. Further coronal holes on the disc may provide some slight enhancement to the solar wind profile from Day 4 (12 Nov). These coronal holes do not align with features on the previous rotation that produced enhancements to the solar winds, as such MOSWOC SWPM is not considered to give good guidance. MOSWOC Enlil however, is considered to be providing reasonable guidance for the forecast period.

Geomagnetic activity expected to be largely Quiet to Unsettled (Kp 0-3) with a chance of an isolated Active (Kp 4) interval during Day 1. As influence from the HSS wanes through Day 2, activity is expected to ease to generally Quiet levels (Kp 0-2).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	2	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil expected.

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Figure 2: SDO/AIA-211 imagery showing the comparison of coronal holes between the previous rotation (image on left, 13 Oct) and present day (image on right, 09 Nov).

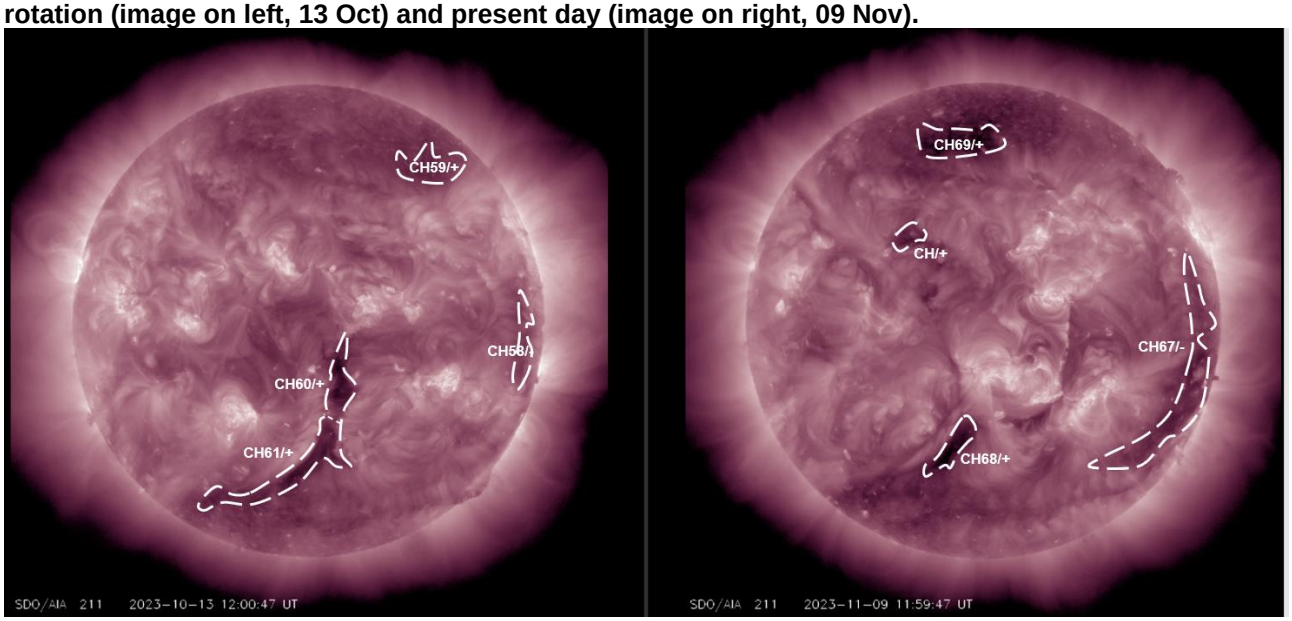


Figure 3: MOSWOC Enlil. Considered to provide good guidance for solar wind speeds through the period.

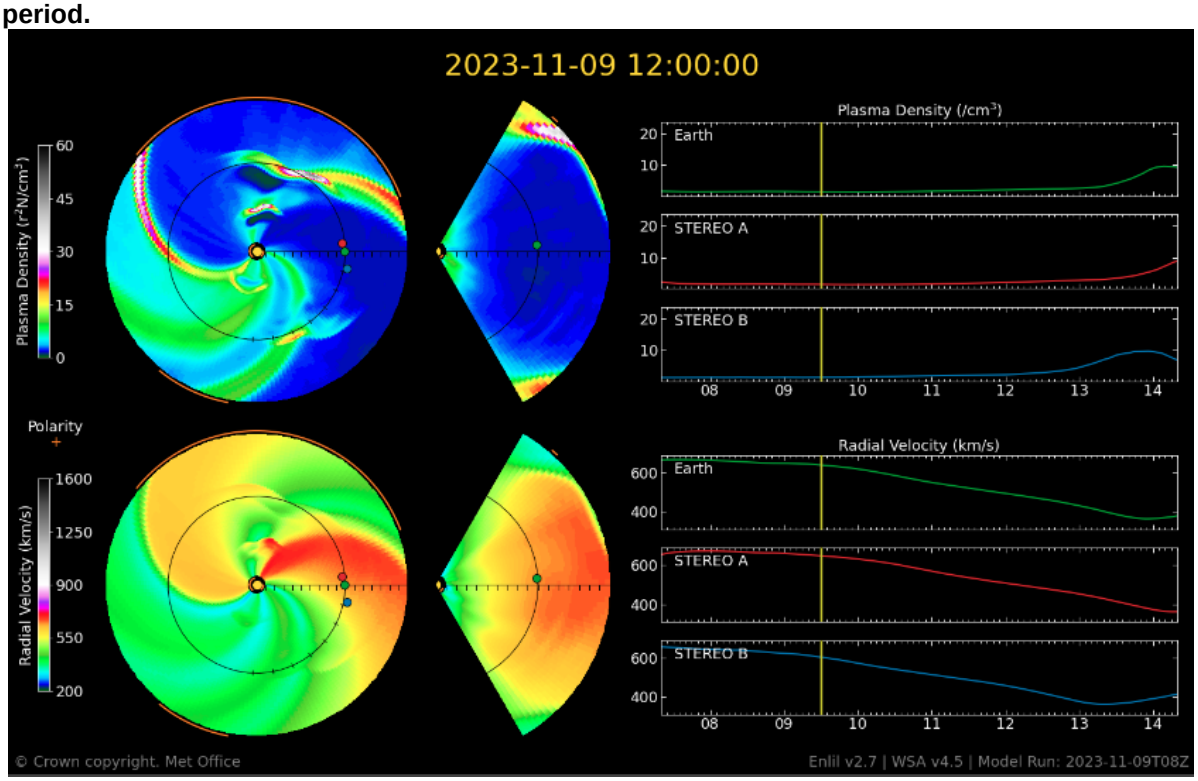
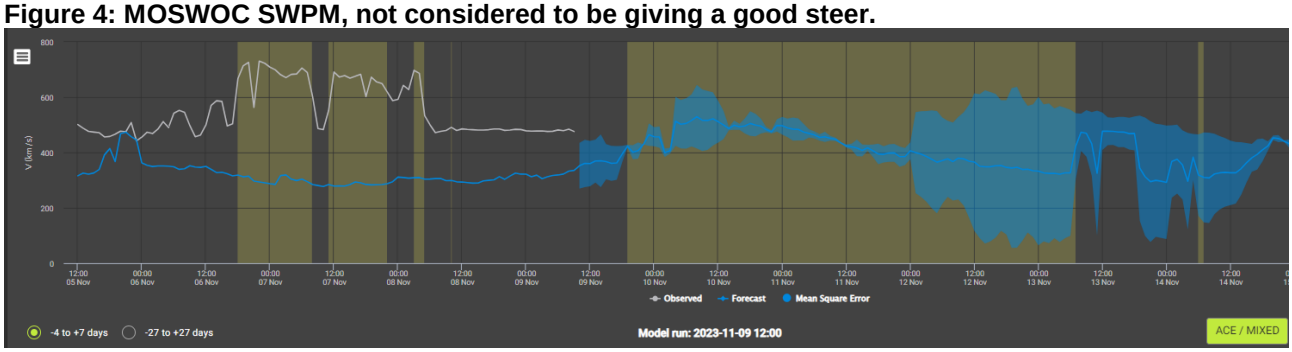


Figure 4: MOSWOC SWPM, not considered to be giving a good steer.



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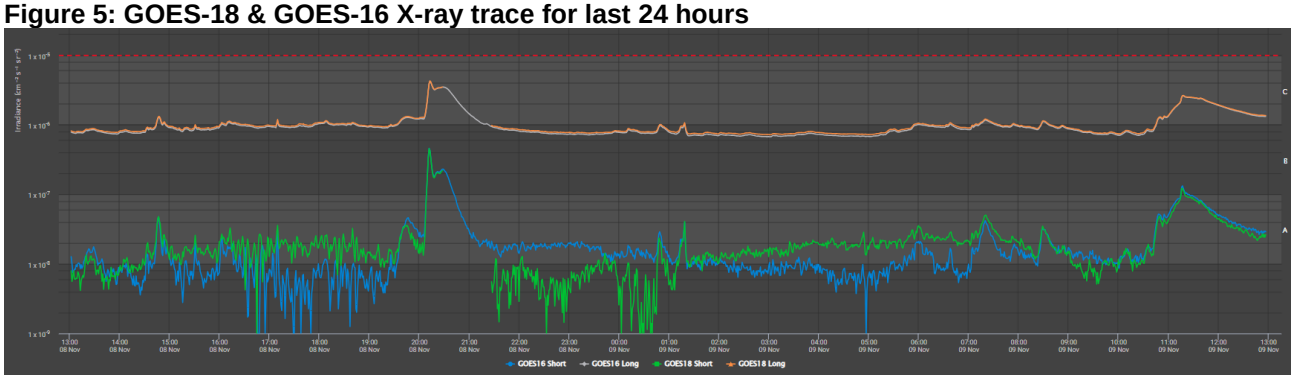
Radio Blackouts - X-Ray Flares:
Activity has been Low with only C-class flares observed in the last 24 hours. AR3483 was responsible for the largest flare, peaking at C4.2 at 08/2013 UTC.

There are currently seven regions on the visible disc, six of which are numbered. The largest region on the disc is AR3477 (Eko/Beta) in the southwest. The most complex regions on the disc are AR3479 (Dri/Beta), close to the western limb, and AR3483 (Eai/Beta-Gamma), near centre disc. The viewing angle of AR3479 is limited and as such the classification is moderate confidence. AR3483 continues to show signs of growth. Due to the complexity of the magnetic field around this region, there is a chance that a delta spot may emerge. A new region continues to emerge in the northwest, close to the region of Ex-AR3481. This has developed quite quickly into a Cso/Beta region. The other regions are all relatively small, simple and stable and have shown only limited signs of growth or decay.

STEREO-Ahead EUVI imagery and seismic signatures suggest that new or returning regions could rotate onto the disc late Day 1 (09 Nov) and through Day 3 (11 Nov).
Generally Low activity is anticipated, but with an ongoing chance of isolated M-Class flares, most likely from emanating from AR3483. The probability of M-class flares is expected to increase slightly as active regions continue to develop and newer regions emerge or rotate onto the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	40	40
Very Active	R3 to R5 X Class	No	1	1	5	5

Figure 5: GOES-18 & GOES-16 X-ray trace for last 24 hours



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels. There is a slight risk of proton enhancement from any larger flares. From Day 3 sunspots AR3477 and AR3483 will be transiting into more favourable geo-effective favourable longitudes giving a slight rise to the probability of an S1 radiation storm.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to be at moderate levels with diurnal periods at high levels. Flux levels became High at 09/1135 UTC. There is a chance that following enhancement of the radiation belt due to the ongoing HSS that the electron flux may remain at high levels for protracted periods Days 1-3 (09-12 Nov).

The associated 24-hour electron fluence is expected to be just below the Active threshold at first, but with an expectation for it to exceed the Active (1e8 integrated pfu) threshold by later Day 1 (09 Nov) and remaining so through Day 2 (10 Nov), with a slight chance of reaching 1e9 integrated pfu. In the absence of further geomagnetic activity to disrupt the radiation belt, fluence levels may remain above the Active threshold until the end of the forecast period. Confidence in this decreases due to uncertainty in the waning influence of the current HSS and the potential for further weak enhancements from coronal hole activity late in the period.

The overall trend of the MOSWOC REFM model looks reasonable, however, maximum fluence values are considered to be on the extreme side.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	80	90	70	70
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	2	5	2	1

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Figure 6: GOES-16 Electron flux trace from last 24 hours

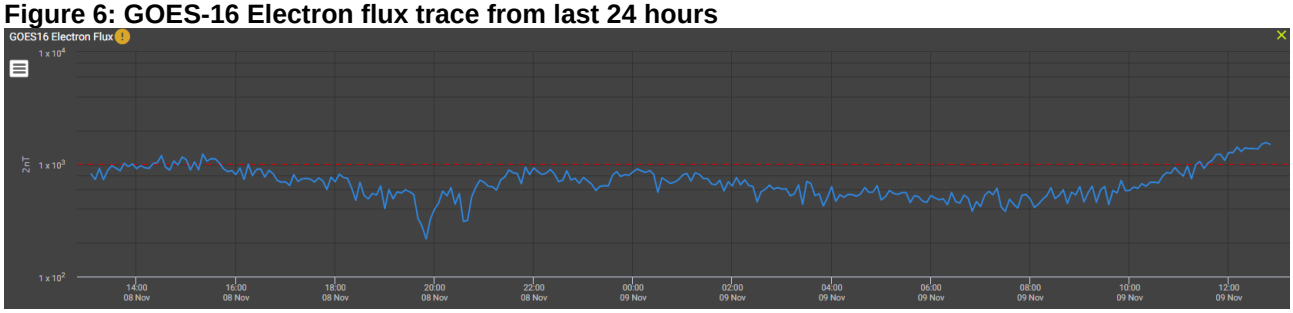
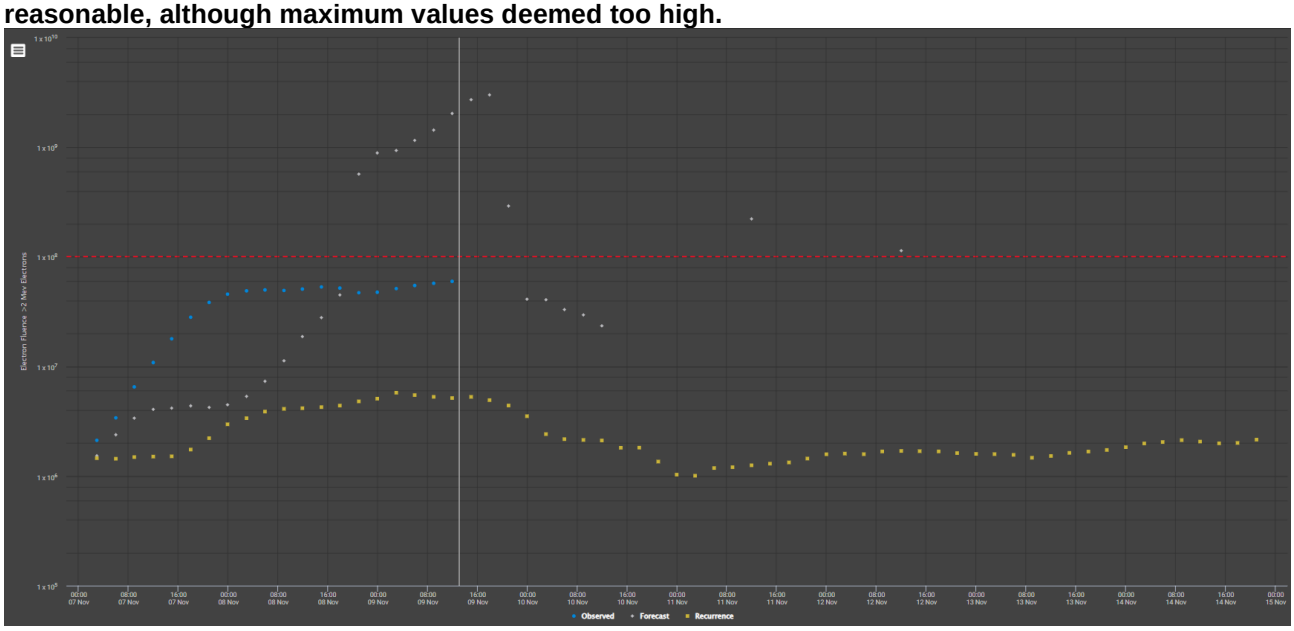


Figure 7: MOSWOC REFM showing projected Active fluence levels. Overall trend considered reasonable, although maximum values deemed too high.



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